MARGINAL NOTES

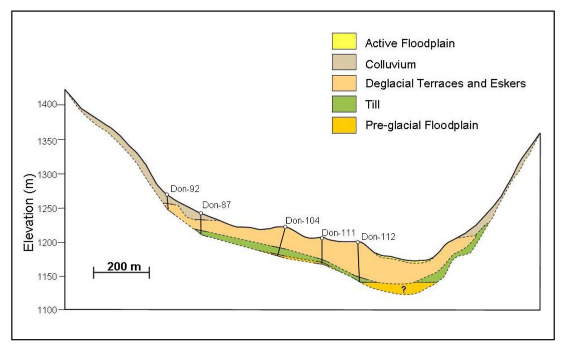
This terrain inventory map was created based on the Terrain Classification System for British Columbia (Howes and Kenk, 1997), with modification to meet standards set by the Yukon Geological Survey and the Geological Survey of Canada. Line-work for the map was produced from interpretations of 1:40 000-scale aerial photos (2004). Subsequent field checking of the map was completed in the summers of 2006 and 2007 by foot and helicopter. A total of 306 sites were visited during the field checking, including multiple stratigraphic sections exposed by road and river cuts. Preserved Quaternary sediments in 19 drill cores provided otherwise inaccessible stratigraphic information.

The study area straddles the continental divide, with the Pelly River flowing west to the Yukon River, and the Nahanni River flowing east to the Mackenzie River. In the Pelly River drainage, broad river valleys oriented east-west contrast with narrower valleys oriented north-south. All the valleys in the study area are steep and sediment-filled. The relief from valley to peak is over 600 m with the highest peaks measuring above 2500 m.

The study area was a major accumulation zone for the Selwyn Lobe during the late Wisconsinan (McConnell) glaciation. This lobe spread west for more than 200 km and was possibly over 2000 m thick at its maximum over the study area (Jackson *et al.*, 1991). Ice-flow indicators such as striations, meltwater channels, eskers, moraines and drumlinized bedrock were used to infer the ice-flow history of the area.

The earliest stage of ice-flow involved valley glaciers originating in local cirques. As these glaciers coalesced and developed into an ice sheet, the ice divide was centred east of the Nahanni River (Turner, *et al.*, 2008). The flow during this stage was southwest across the study area and completely covered the landscape. Prior to deglaciation, the ice divide migrated across the study area and ice flowed dominantly north. As the ice sheet melted, increased topographic control channeled ice-flow parallel to the major valleys. Deglaciation in the study area commenced through rapid starvation and widespread stagnation of the ice sheet.

STRATIGRAPHY



Cross-section of the surficial materials near Don-104. Depths of the materials are inferred from Quaternary sediments in five drill holes. The lower pre-glacial floodplain is inferred from the presence of unit 1.

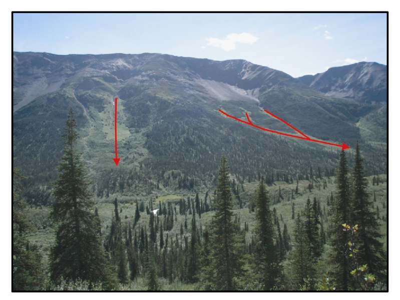


Figure 1. Avalanche and debris flow tracks on the side of Don Valley. The pattern of vegetation in these tracks indicates multiple recent events.

Figure 2. Solifluction lobes on a north-facing slope as an example of periglacial mass movement processes.

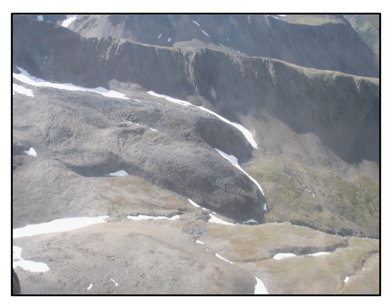


Figure 3. Rock glaciers such as this are common in north-facing cirques. Some extend to valley bottoms and are over a kilometre in length.

Figure 4. Meltwater channels are common on valley sides across the study area. The ones pictured above formed laterally on the glacial margin. Arrows indicate interpreted direction of flow of the meltwater channel.

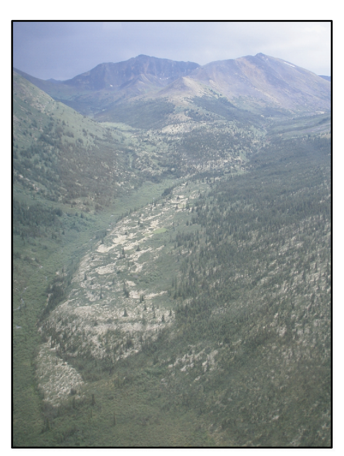
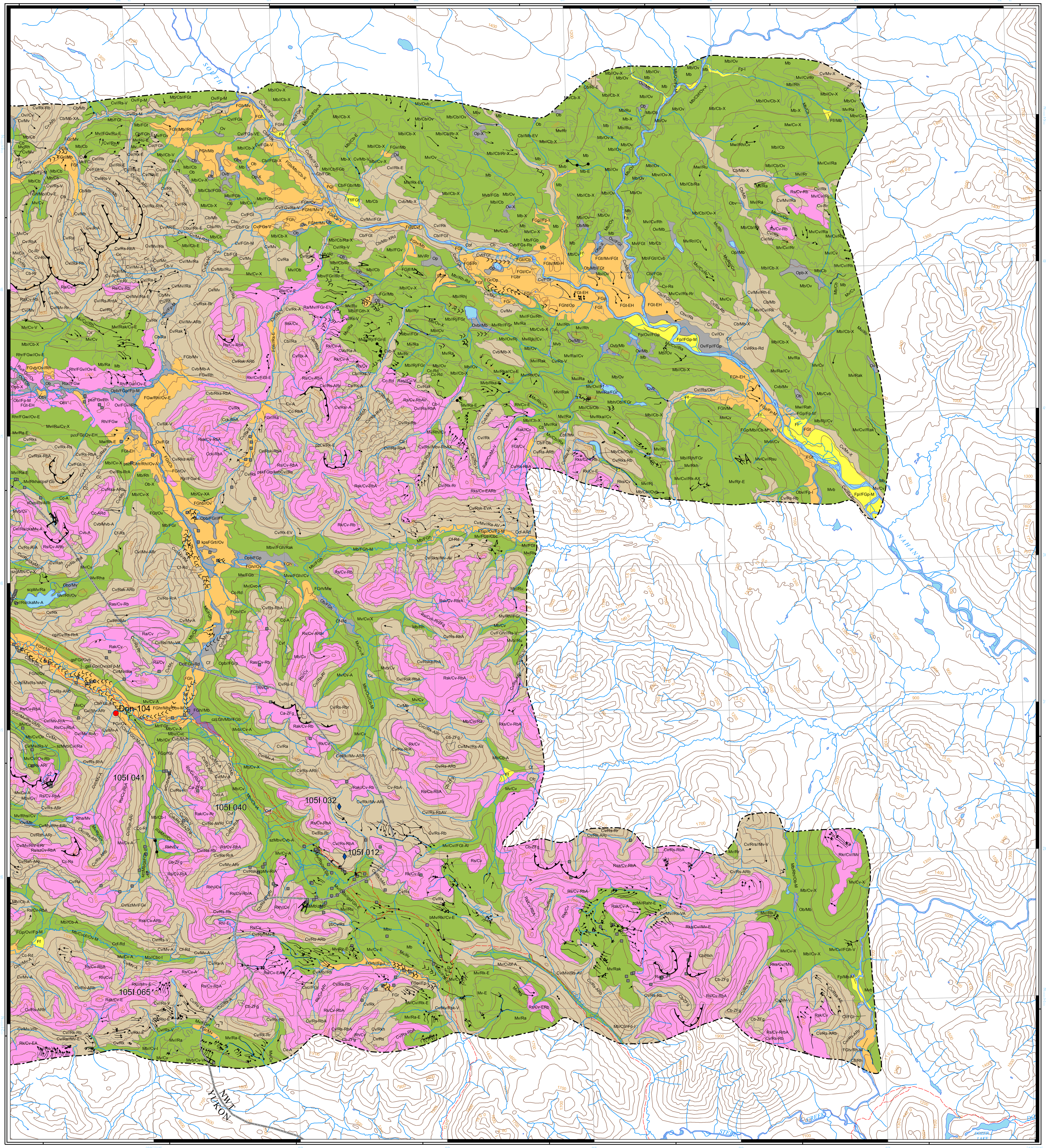
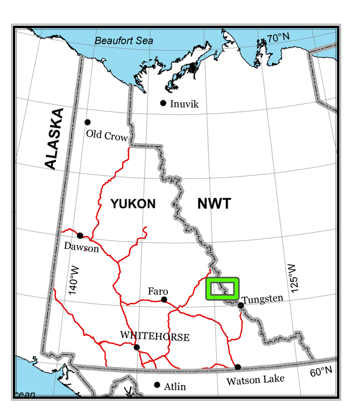


Figure 5. Kame terrace in a tributary to the Don Valley. The surface is heavily kettled from the melting of buried ice blocks.

Figure 6. An example of zinc-rich moss accumulated from streams and springs running through mineralized zones.





1:50 000-scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA

ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 9

CONTOUR INTERVAL 100 METRES
Elevations in metres above Mean Sea Level

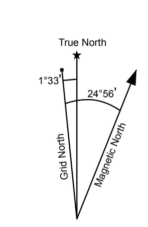
Terrain Inventory

HOWARD'S PASS

YUKON/NWT 105I/11
and parts of 105I/10, 6 and 7

SCALE 1:50 000

0 1 2 3 4 5
kilometres



Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION JULY 2007
FOR CENTRE OF MAP

105I/13 MOUNT WILSON	105I/14	105I/15
105I/12	105I/11 MAP LOCATION	105I/10
105I/05	105I/06	105I/07

SURFICIAL MATERIAL

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. On the map, surficial materials form the core of the polygon label. They are symbolized with one or two upper case letters, with texture written to the left, and surface expression of glacial qualifier to the right. The glacial qualifier "G" was used to describe glacially modified materials. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that unit.

C — Colluvium: colluvium is material that was transported and directly deposited by down-slope, gravity-driven processes such as creep, all landslides and snow avalanches. The texture and composition of colluvium vary more than any other material in the map area, depending on the parent material and the mechanism and distance transported. For example, materials derived from a glaciofluvial source will likely contain well rounded, well sorted clasts of diverse lithology. Comparatively, colluvium derived from physically weathered bedrock will be angular and poorly sorted. Some materials formed by rapid processes, such as rock falls, debris flows and avalanches (Fig. 1), are deposited within tens of seconds and are typically found on steep to moderate slopes. Conversely, slow processes associated with permafrost, like solifluction and creep, occur on gentle slopes (Fig. 2); rock glaciers are present in most north-facing cirques (Fig. 3). The most common form of colluvium in the map area is a mix of colluviated till and bedrock, resulting in silt diamicton with angular, local bedrock and sub-rounded erratic clasts. Thus, the utility of colluvium as aggregate material also differs across the study area. In some areas, colluvium can be used as fill material. However, due to the hazards commonly associated with this material, sites with colluvium are not recommended for infrastructure development.

F — Fluvial: fluvial materials are transported and deposited by modern streams and rivers flowing throughout Howard's Pass. They typically consist of stratified sand and gravel with well-sorted and well-rounded clasts. Most of these deposits are limited to floodplains, terraces and fans, such as the Pelly and the Nahanni, these materials can be substantial. Floodplains are generally poor sites for development despite favourable foundation conditions. This is due to potential flooding, especially from ice jams during break-up. Many smaller streams transporting sediment down mountain sides develop fans in valley bottoms. These features may contain useful aggregate materials, but they are also prone to hazards such as debris flows, debris floods and rapid channel avulsions.

FG — Glaciofluvial: glaciofluvial materials have been deposited directly by glacial meltwater. These deposits can form supra-, en- or subglacially, as well as in front of, or adjacent to, a glacier. They are deposited in meltwater channels (Fig. 4), eskers, terraces (Fig. 5) and kames. They typically consist of moderately to well-sorted, rounded, stratified sand and gravel, but can vary locally depending on transport distance. Their quality as an aggregate resource varies, with some gravel consisting of poorly indurated shales that break down easily. Well-drained glaciofluvial deposits result in few segregated ice lenses, making them good locations for roads and other infrastructure.

M — Morainal: morainal describes diamicts deposited by either primary glacial processes such as lodgement, deformation and melt-out, or secondary glacial processes caused by gravity and water (Dreimanis, 1989). Thus, this term applies to all types of till including flow tills, which are not directly deposited by glacial ice. In the map area, till is composed of clayey silt diamicton with 10 to 40 % clasts, but varies widely in grain size distribution and clast lithology. Till locally contains segregated ice lenses, so development on northern or organic-mantled slopes should proceed with caution. It is suitable as a bulk fill and, because of its fine-grained matrix, as an impermeable liner for tailing ponds.

LG — Glaciolacustrine: glaciolacustrine materials have been deposited in a lake on, in, under or beside a glacier. Glaciolacustrine sediments are rare. They are mostly restricted to small tributary valleys or adjacent to glaciofluvial ridges and hummocks. Glaciolacustrine sediments consist of stratified sand, silt and clay. Their low permeability, poor drainage, and high in-situ moisture content can result in ice lenses that melt and cause large slumps. However, the high impermeability of glaciolacustrine materials makes them excellent liner material for tailing ponds.

O — Organic: organic deposits are accumulations of vegetative matter thicker than 1 m. They are commonly found in floodplains, areas of shallow permafrost, and other locations with poor drainage. Abundant small tussocks throughout the study area indicate active ground ice in organic materials. In zinc-rich areas in Howard's Pass, organic deposits are highlighted by bright green mosses fed by spring water (Fig. 6; Jonasson *et al.*, 1987; Goodfellow, 1989). Their susceptibility to freeze-thaw processes and their compressibility makes organic sediments a poor foundation material.

R — Bedrock: the bedrock surficial material label was used for areas where bedrock outcrops or is covered by a thin veneer of sediment. The dominant lithologies in the map area are Rabbitkettle basinal carbonates, Road River cherts and shales, and Earn Group clastic rocks (Gordey, 1981). Bedrock outcrops occur mostly on steep slopes at high elevations. However, in several areas, outcrops occur as hummocks and ridges in valley bottoms. The high fracture density in these lithologies results in frequent bedrock failures such as rock falls and slides. Highly fractured bedrock is therefore not recommended for foundation material.

SURFACE EXPRESSION

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the land surface. This three-dimensional shape of the material is equivalent to 'landform' used in a non-genetic sense (*e.g.*, ridges, plain). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (*e.g.*, veneer). Surface expression is indicated by up to three lower case letters, placed immediately following the surficial material designator, listed in order of decreasing extent.

a - moderate slope: unidirectional (planar) surface; 16-26° (27-50%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m

b - blanket: a layer of unconsolidated material thick enough (>1 m) to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography; outcrops of the underlying unit are rare

c - cone: a cone or sector of a cone, mostly steeper than 15° (26%); longitudinal profile is smooth and straight, or slightly concave/convex; typically applied to talus cones

f - fan: sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longtitudinal profile is smooth and straight, or slightly concave/convex

h - hummock: steep sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15-35° (26-70%) if composed of unconsolidated materials, whereas bedrock slopes may be steeper; local relief >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to knob-and-kettle glaciofluvial terrain

j - gentle slope: unidirectional (planar) surface; 4-15° (7-26%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m

k - moderately steep slope: unidirectional (planar) surface; 27-35° (50-70%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m

m - rolling: elongate hillock(s); slopes dominantly between 3-15° (5-26%); local relief >1 m; in plan, an assemblage of parallel or sub-parallel linear forms with subdued relief (commonly applied to bedrock ridges and fluted or streamlined till plains)

p - plain: a level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities generally <1 m; applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains

r - ridge: elongate hillock(s) with slopes dominantly 15-35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper; local relief is >1 m; in plan, an assemblage of parallel or sub-parallel linear forms; commonly applied to drumlinized till plains, eskers, morainal ridges, crevasse fillings and ridged bedrock

s - steep slope: unidirectional (planar) surface; >35° (70%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m; bedrock slopes may be more irregular; commonly applied to terrace scarps, gully side walls and bedrock cliffs

t - terrace: a single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface above it; applied to fluvial and lacustrine terraces and stepped bedrock topography

u - undulating: gently sloping hillock(s) and hollow(s) with multidirectional slopes up to 15° (26%); local relief >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to till plains, sand dunes and kame topography

v - veneer: a layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material; 10 cm - 1m thick; commonly applied to eolian/loess veneers and colluvial veneers

w - mantle of variable thickness: a layer or discontinuous layer of surficial material of variable thickness (0-3 m) that fills or partly fills depressions in an irregular substrate

TEXTURE

The texture was only specified in polygons that were field checked. It refers to the size, rounding and sorting of the grains in a material. Sorting refers to the distribution of grain sizes in the material. Both roundness and grain size are indicated on this map with different combinations of texture symbols. For example, angular clasts between 2 to 256 mm are rubble (r), whereas well-rounded clasts of the same range in grain size are gravel (g). Similarly, sorting is indicated by combining several different texture symbols. For example, a mixture of silt (z), sand (s) and mixed fragments (d) is very poorly sorted and is a diamicton. Comparatively, a polygon with only one textural symbol is considered well-sorted. Texture symbols are listed before the surficial materials in order of decreasing significance.

a - Blocks: Angular grains >256 mm

b - boulders: rounded grains >256 mm

k - cobbles: rounded grains between 64 - 256 mm

p - pebbles: rounded grains between 2 - 64 mm

s - sand: grains between 0.0625 - 2 mm

z - silt: grains between 0.002 - 0.0625 mm

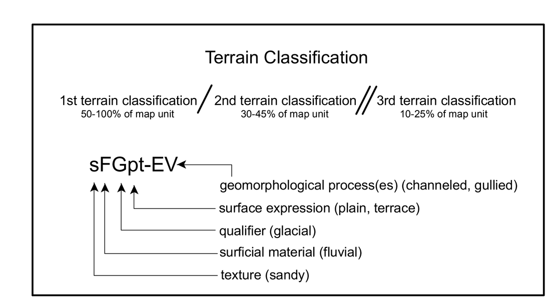
c - clay: grains <0.002 mm

d - mixed fragments: mixed round and angular grains >2 mm

x - angular fragments: mixed angular grains >2 mm

g - gravel: mixed rounded grains >2 mm

r - rubble: angular grains between 2 -256 mm



Mineral Occurrences
Yukon MINFILE (Deklerk, 2008)

105I 012	◆	Howard's Pass	showing	Zn, Pb	SEDEX
105I 040	●	Winkie	unknown	Pb, Zn	
105I 041	●	Ness	unknown	Cu	
105I 065	●	Candy	unknown		
105I 034	●	Black Giant	unknown		
105I 032	◆	Shield	showing	Zn, Pb	SEDEX

SYMBOLS

- glacially aligned landform; striae - unknown direction
- glacially aligned landform; rat-tail - known direction
- glacially aligned landform; streamlined bedrock
- esker; known direction
- esker; unknown direction
- moraine ridge
- glacial meltwater channel - minor - known direction
- glacial meltwater channel - minor - unknown direction
- cirque
- trails
- station locations 2006 and 2007
- section locations

GEOLOGICAL BOUNDARIES

- defined boundary
- approximate boundary
- limit of surficial geological mapping

ADMINISTRATIVE BOUNDARIES

- territorial boundary

GEOMORPHOLOGICAL PROCESSES

Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth's surface. Unless a qualifier (A (active) or I (inactive)) is used, all processes are assumed to be active, except for deglacial processes. Process is indicated by up to three upper case letters, listed in order of decreasing importance, placed after the surface expression symbol, and separated from the surface expression by a dash (-).

Subclasses can be used to provide more specific information about a general geomorophological process, and are represented by lower case letter(s) placed after the related process designator. Up to three subclasses can be attached to each process. Process subclasses used on this map are defined with the related process below.

EROSIONAL PROCESSES

V - gully erosion: running water, mass movement and/or snow avalanching, resulting in the formation of parallel and sub-parallel long, narrow ravines

FLUVIAL PROCESSES

I - irregularly sinuous channel: a clearly defined main channel displaying irregular turns and bends without repetition of similar features; back channels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent

M - meandering channel: a clearly defined channel characterized by a regular and repeated pattern of bends with relatively uniform amplitude and wave length

MASS MOVEMENT PROCESSES

A - avalanche: rapid downslope movement of snow and ice, as well as incorporated rock and surficial material, by flowing or sliding

F - slow mass movements: slow downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding

subclasses: (g) rock creep - slow movement of angular debris under periglacial conditions

R - rapid mass movements: rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris derived from surficial material and/or bedrock

subclasses: (d) debris flow - rapid flow of saturated debris; (r) rockslide - sliding mass of disintegrating bedrock; (b) rockfall - descent of masses of bedrock by falling, bouncing or rolling; (s) debris slide - sliding mass of disintegrating surficial material

PERIGLACIAL PROCESSES

X - permafrost processes: processes controlled by the presence of permafrost, and permafrost aggradation or degradation

Z - general periglacial processes - solifluction, cryoturbation and nivation, possibly occuring in a single polygon

DEGLACIAL PROCESSES

E - channeled by meltwater: erosion and channel formation by meltwater alongside, beneath, or in front of a glacier

H - kettled: depressions in surficial materials resulting from the melting of buried glacier ice

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RECOMMENDED CITATION

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Digital cartography and drafting by Aero Geometrics Ltd. and Shannon Mallory and Bailey Staffen with the Yukon Geological Survey using ArcMap. Mapping based on hard-copy air photo interpretation using 1:40 000-scale 2004 airphotos. Field checking was performed in the summers of 2006 and 2007.

Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey.

Paper copies of this map, the accompanying report and Yukon MINFILE may be purchased from Geoscience Information and Sales, c/o Whitehorse Mining Recorder, Energy, Mines and Resources, Yukon Government, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5. Ph. 867-667-5200, Fx. 867-667-5150, Email geosales@gov.yk.ca.

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Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2008-20

Surficial Geology of the Howard's Pass area (NTS 105I/11 and parts of 105I/10, 6 and 7), Yukon and Northwest Territories. (1:50 000 scale)

by

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